Bill, Eric, Frank, Ray, Ron
July 27 2004

"Current" Status of the TDC Readout

Since the last time we met...

→ *Understand tails in the readout*

→ *Using "speedup bits" in the Universe VME chip*

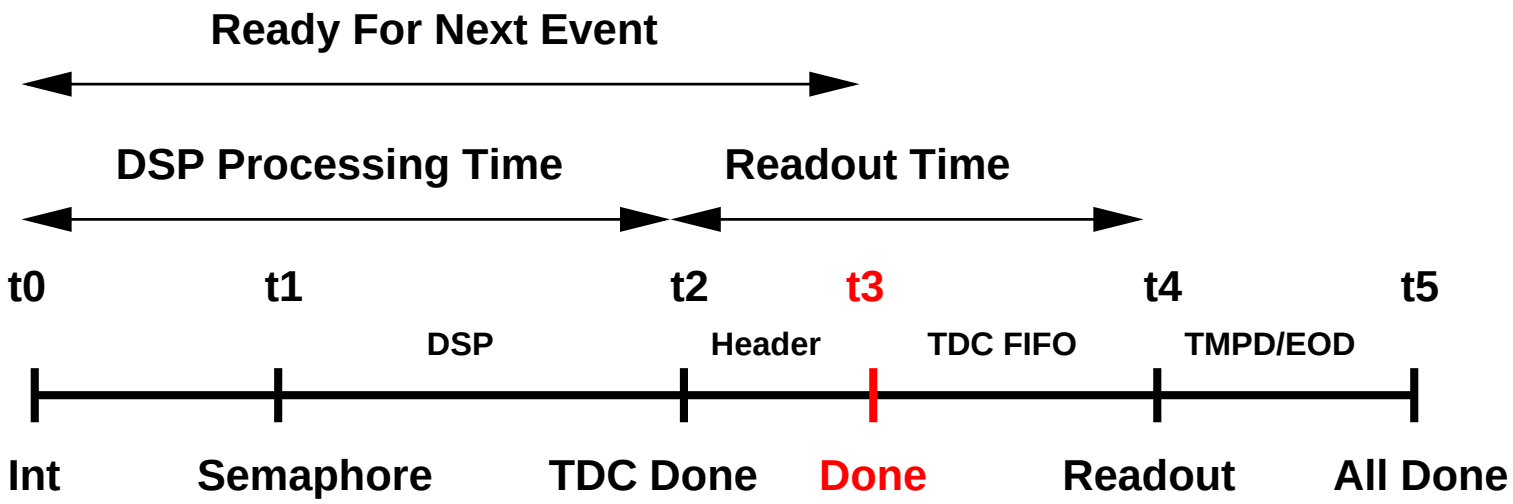
→ *Implemented new DSP code (V64) with new format*

→ *Measured rates with new DSP*

→ *Took a cosmic run with new DSP*

→ *MVME 5500 status*

Timing information is stored for each event in the TMPD bank



In order to get a unbiased look at the data, selected events from the L3 Monitor path

Ran over the "d stream" and used the prereq module:

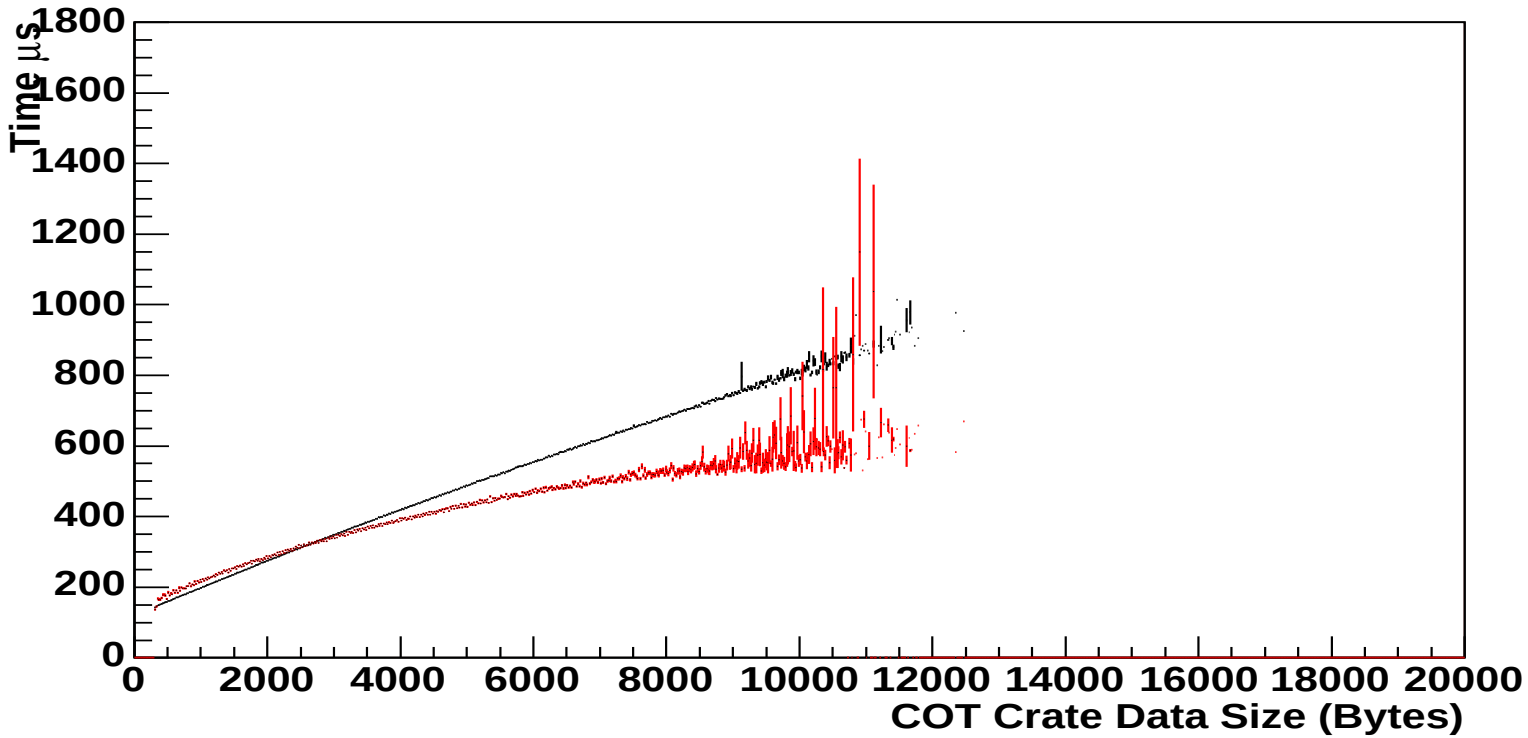
```
L3TriggerNames     set MONITOR_L3TAG
```

→ Recently added a new measurement point (Tracer Done Set)

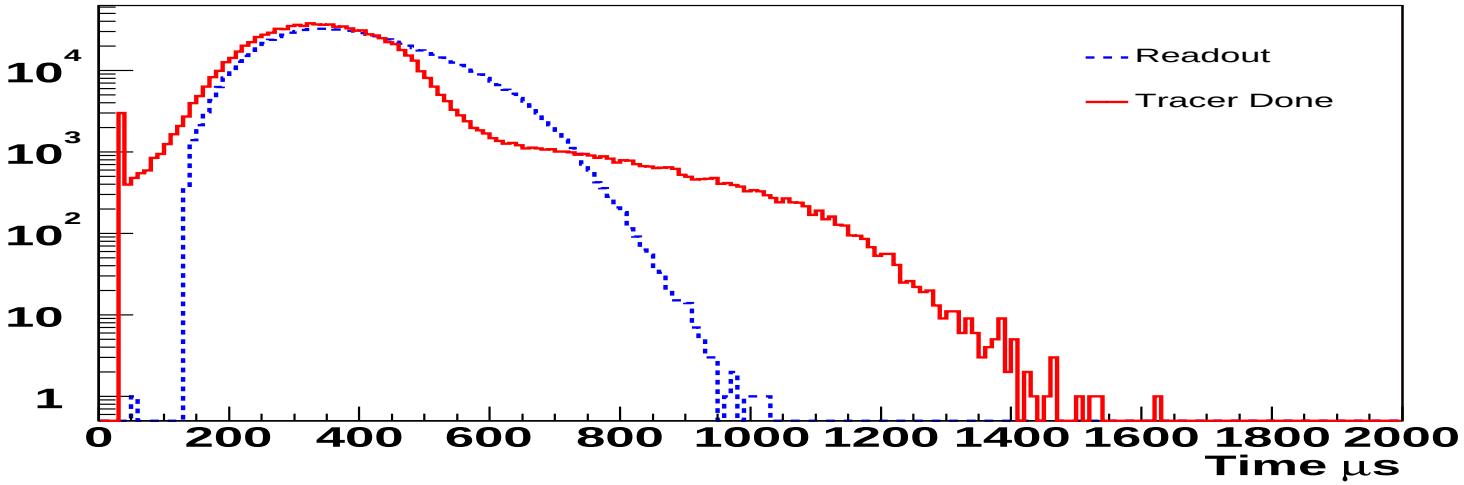
Comparing Readout Time with DSP Times for V45

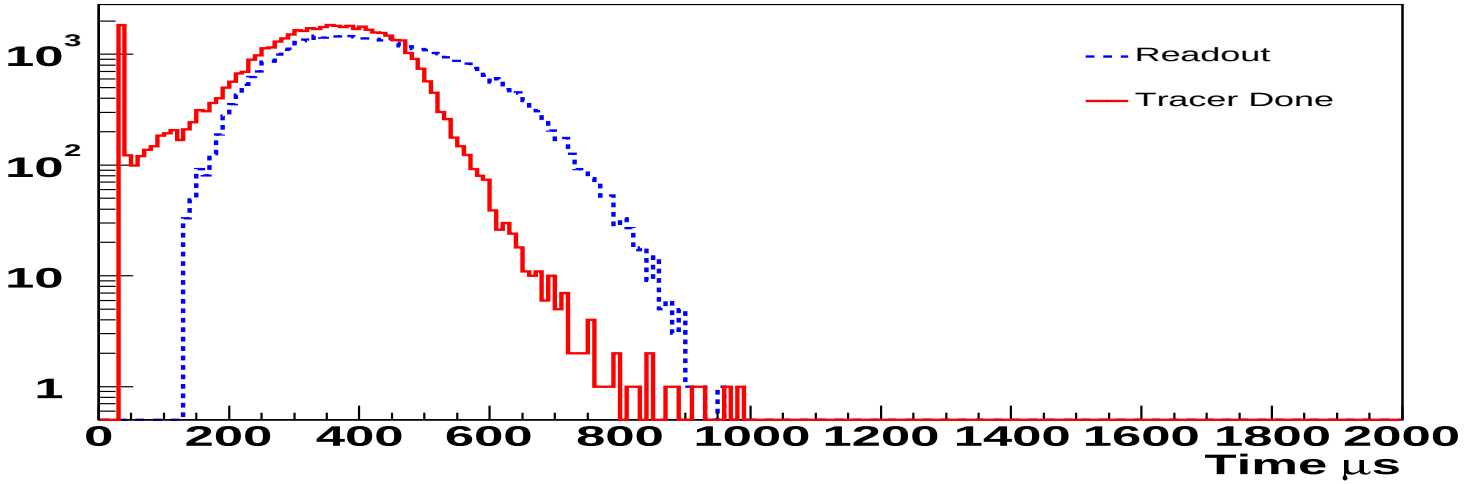
The Tracer Done is set before the TDCs are readout

→ The maximum of Readout Time or DSP processing time limits our readout



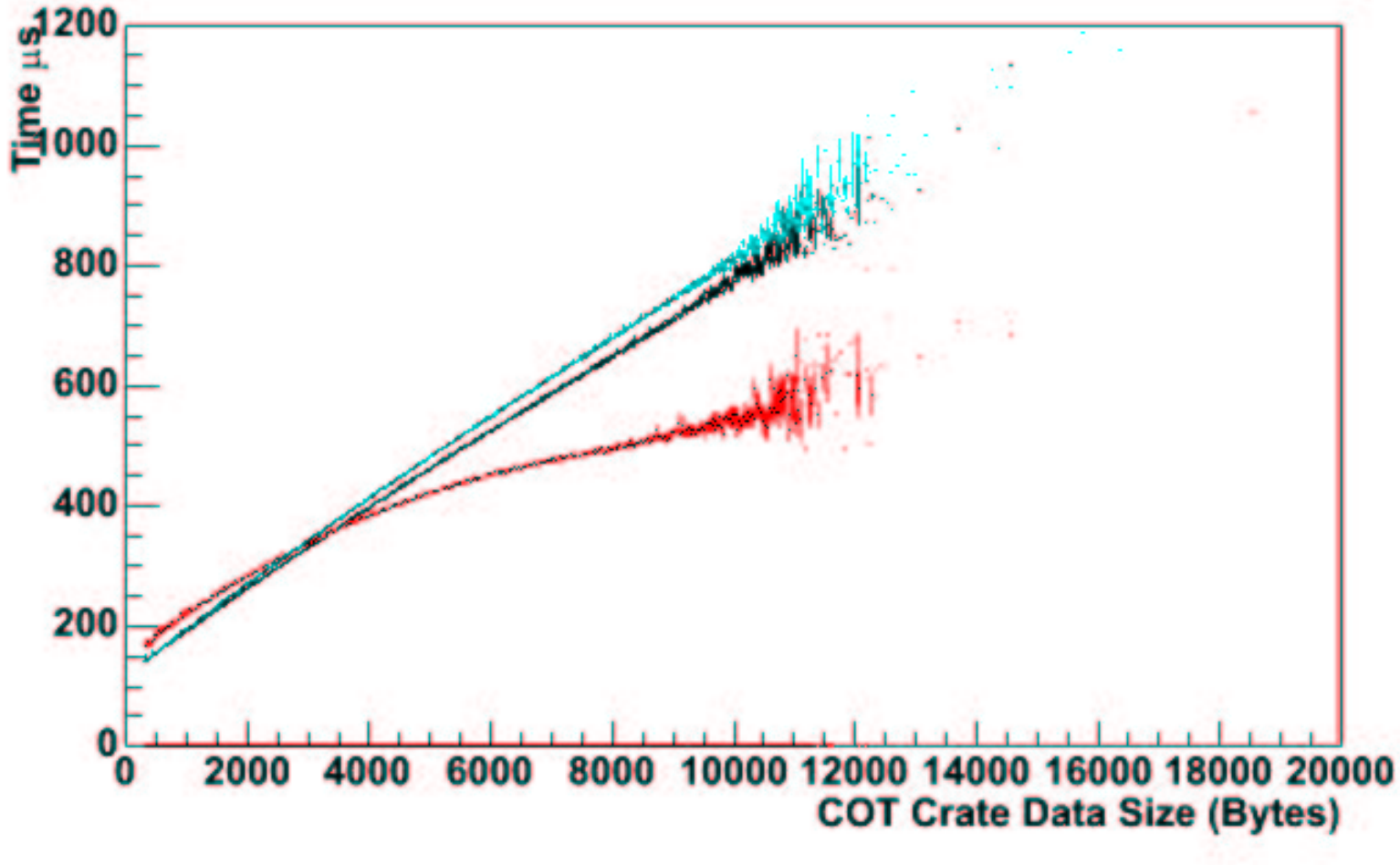
Tails in the readout are now understood





Turns out that b0cot01 has been running in local-done/non-spy mode readout for quite some time (a year or two?).

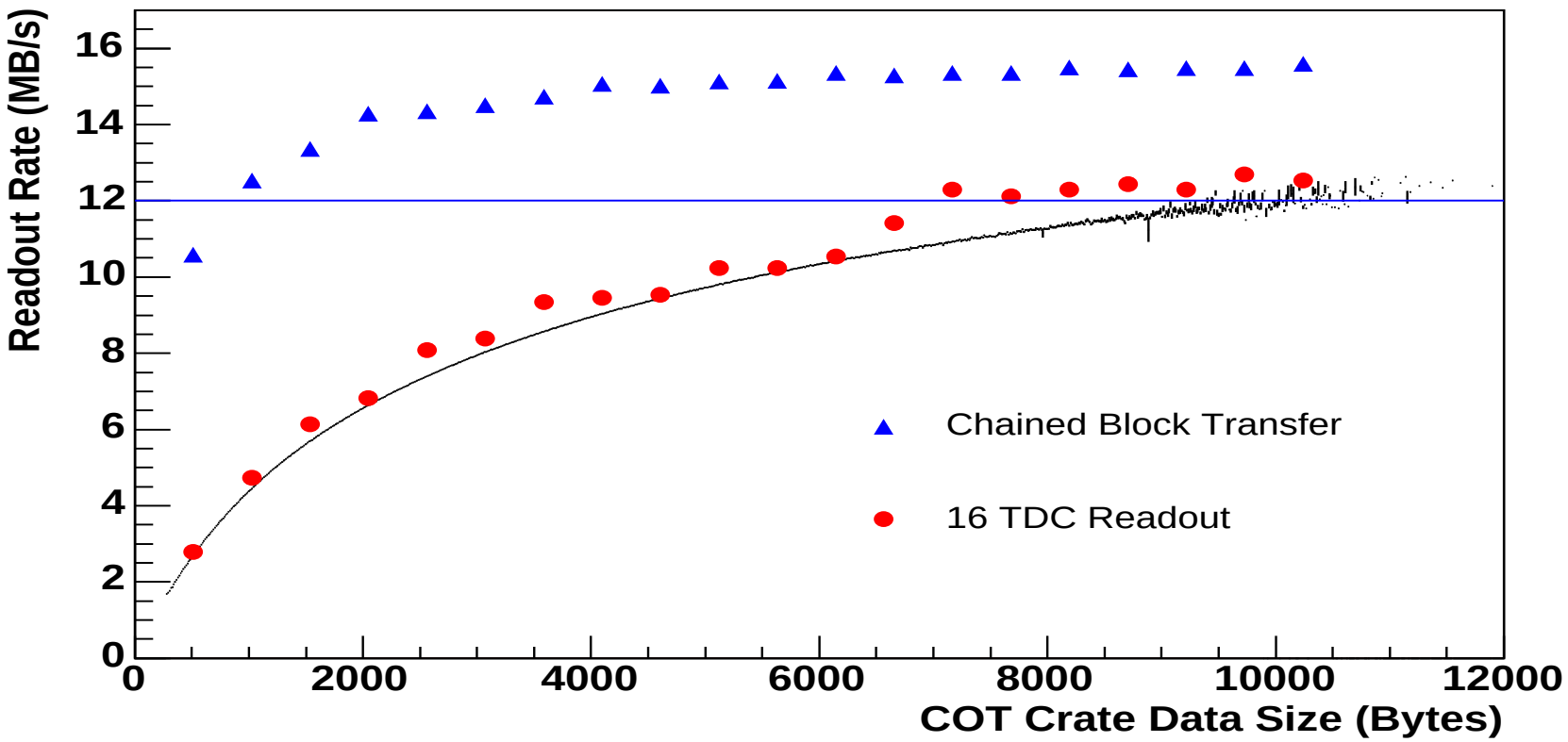
There are several bits available which control the Universe chip



Tweaks provide a marginal improvement in the readout times

TDC Readout limit $\sim$ 15.8 MB/s

Tracer Readout limit $\sim$ 12 MB/s



$\rightarrow$ Chained Blk: Read header, read TDC fifo

$\rightarrow$ 16 TDC Readout: 16$\times$ read header, 16$\times$ read TDC fifo

Chained block mode: 12 $\rightarrow$ 15.5 MB/s

We run in SPY mode when reading out the TDCs.

→ Data is caught on the backplane as the TDC is readout and shipped out through the TRACER. Does not require a Read/Write

With the MVME5500 we need to read the data over the backplane *and then* transfer over GigE.

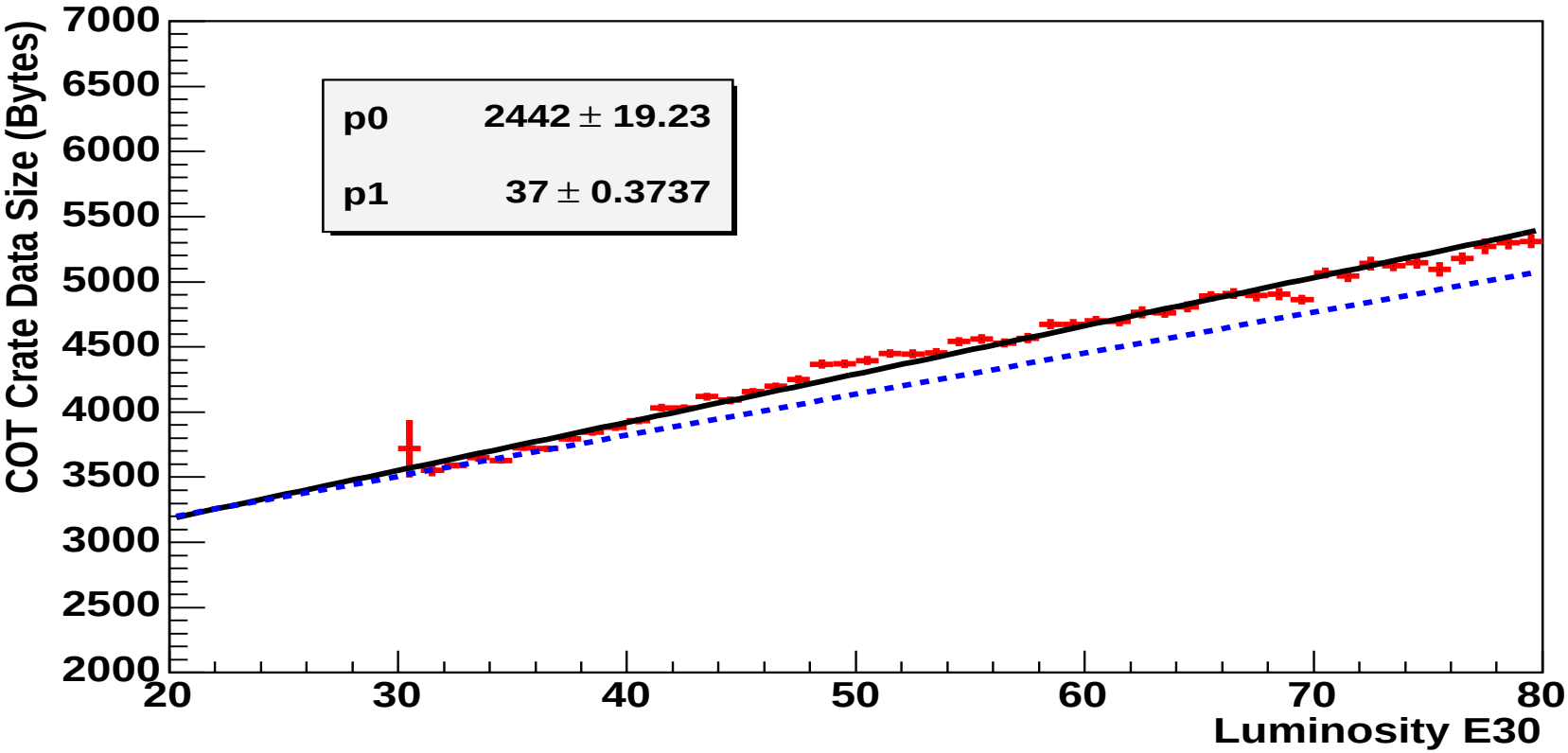
```
GigE                      60 MB/s
TDC readout               15 MB/s
Read VME/Write GigE       12 MB/s

VMEbus   BLT              40 MB/s (Tundra Universe II ~25 MB/s)
VME64    MBLT             80 MB/s (Tundra Universe II ~50 MB/s)
VME64x   2eVME           160 MB/s
VME321   2eSST    320-500+ MB/s
```

Unless the VME readout rate is significantly higher that 15 MB/s it will be a challenge to achieve a sustained throughput near 15 MB/s

The MVME5500 will not improve the readout rate when using the existing TDCs - but it can allow us spread out the data across the more SCPUs reducing congestion further downstream

Average event size from the COT crates versus luminosity

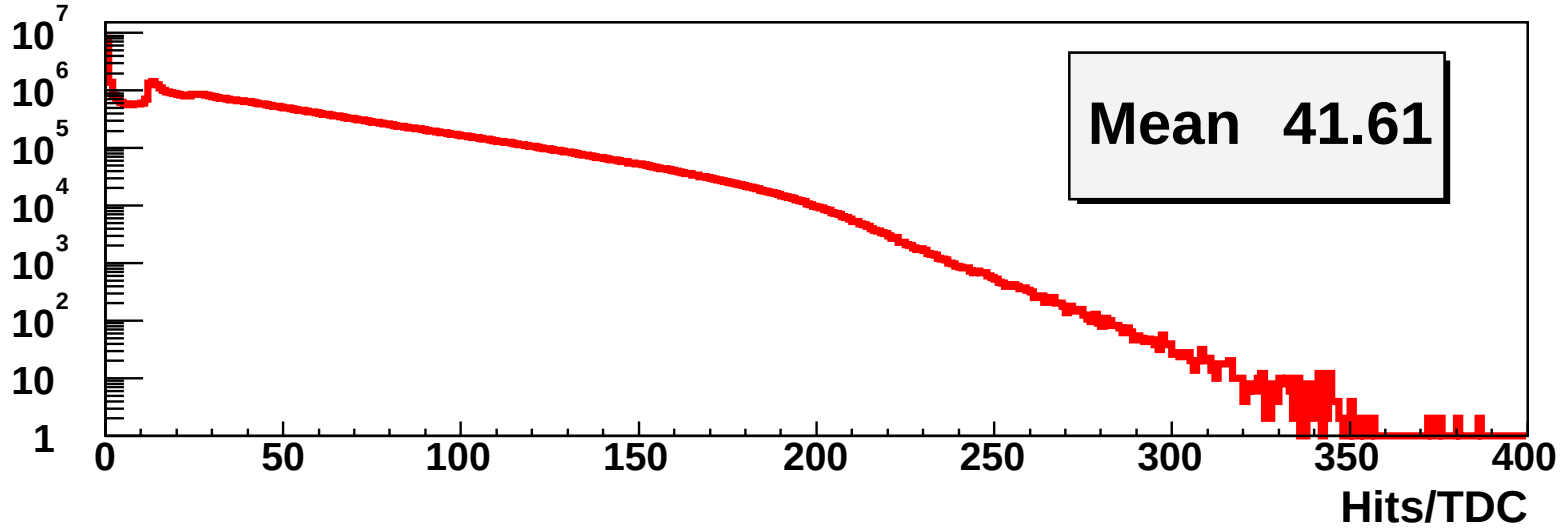
Run 185201

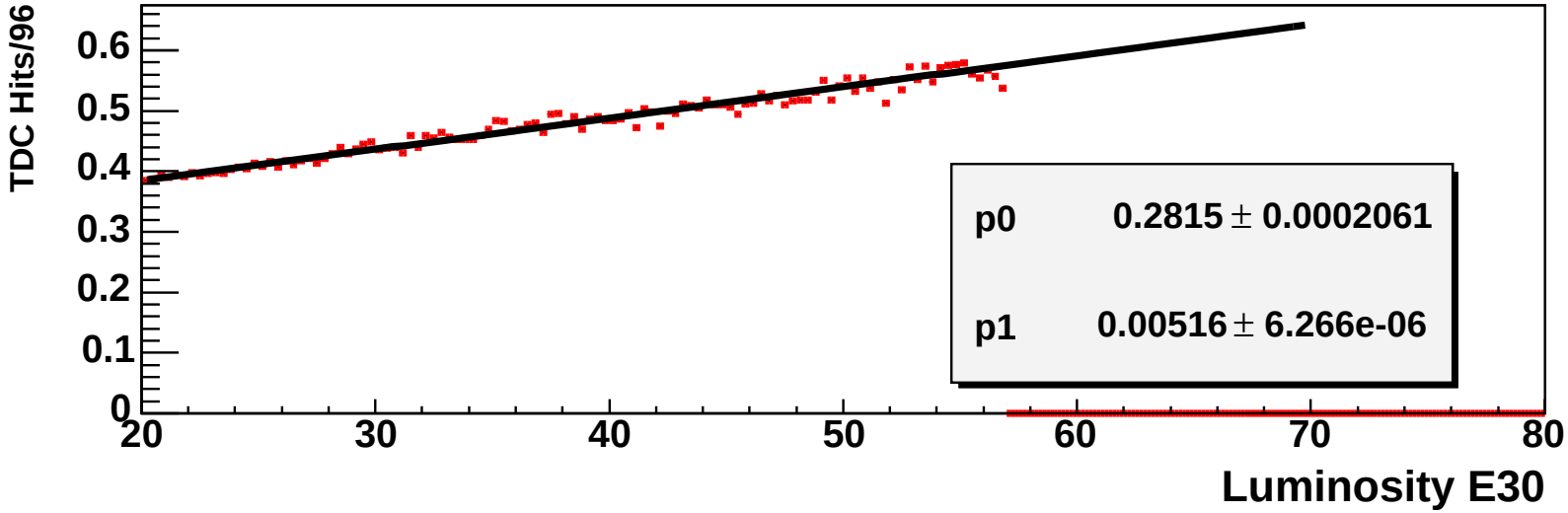


Extrapolation to Run IIb luminosity (330×10^{30})

$$2442 + 37 \times 330 = 14652 \quad \text{bytes}$$

$14652 \times 1/2 = 7326$ bytes/Crate

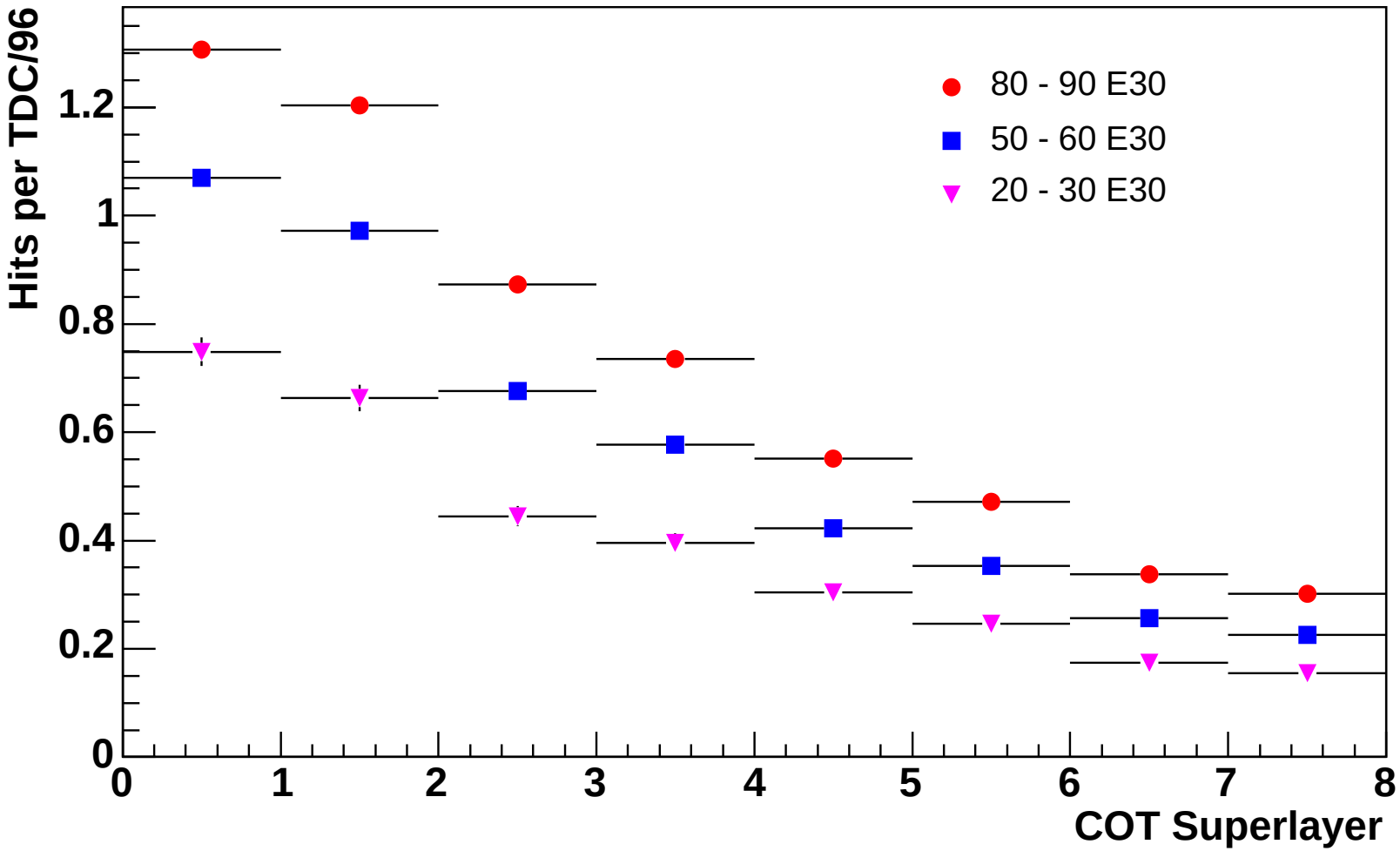




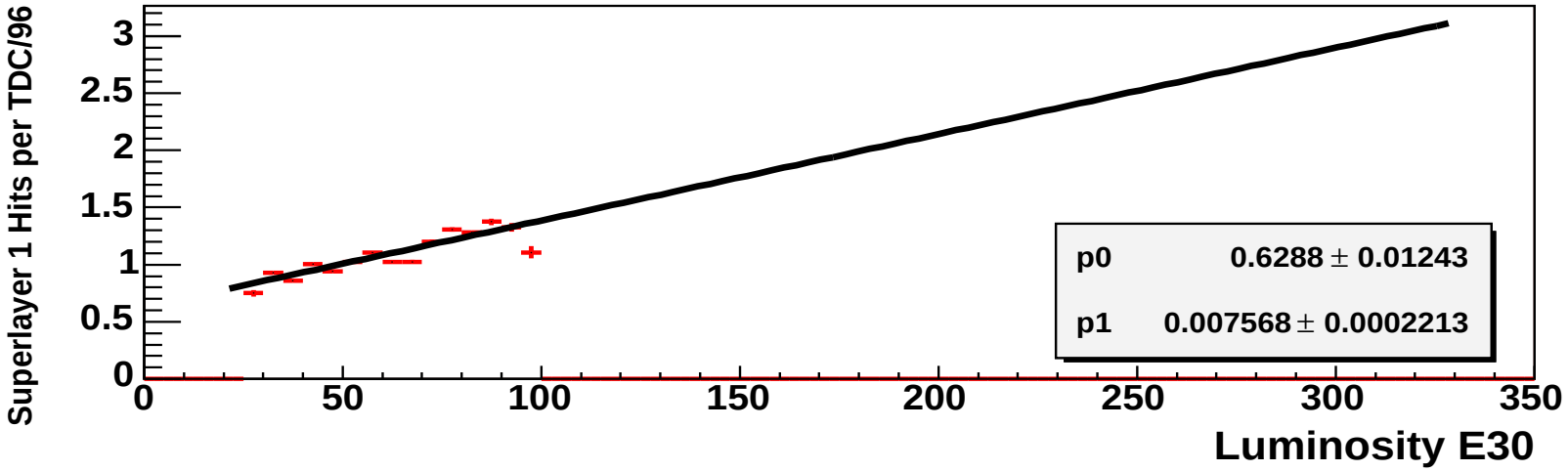
Extrapolation to Run IIb luminosity (330×10^{30})

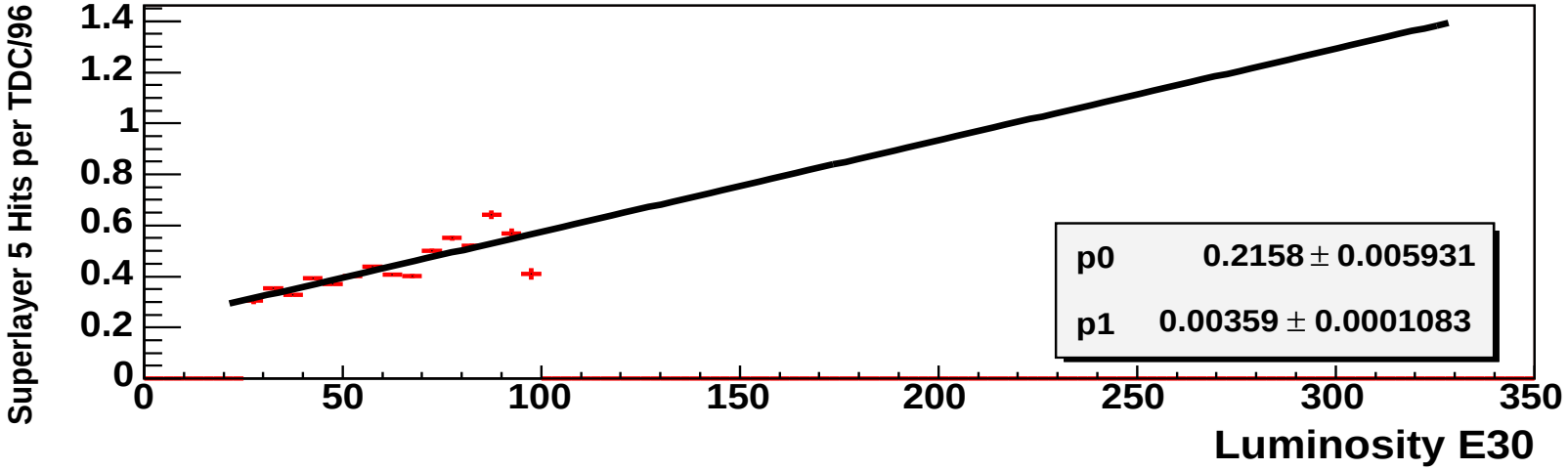
$$0.28 + 0.005 \times 330 = 1.93 \quad \text{hits/channel}$$

TDC Occupancy for each Superlayer



Fast Clear is available for SL1 - SL4





Extrapolation to Run IIb luminosity (330×10^{30})

$$SL1 : 0.6288 + 0.007568 \times 330 = 3.1 \quad \text{hits/channel}$$

$$SL5 : 0.2158 + 0.00359 \times 330 = 1.4 \quad \text{hits/channel}$$

Target Rates

```
Number of TDCs/crate:     15 - 17
Number of channels/TDC:   96
Bytes (1 hit/channel):    17*(4+96*4)

Event Size/Crate:
1 hit/channel:             6596 Bytes
2 hits/channel:           13124 Bytes
3 hits/channel:           19652 Bytes
4 hits/channel:           26180 Bytes

Target Rate 1000 Hz:
1 hit/channel:             6.6 MB/s   * 1/2 =  3.3 MB/s
2 hits/channel:           13.1 MB/s   * 1/2 =  6.6 MB/s
3 hits/channel:           19.7 MB/a   * 1/2 =  9.9 MB/s
4 hits/channel:           26.1 MB/a   * 1/2 = 13.1 MB/s
```

Pulsing the COT

We currently have a rate limit of 380-450 Hz due to the EVB

→ In order to estimate the maximum readout rate that can be achieved with the new DSP version we pulsed the COT chamber and readout the TDCs without sending the data to the VRBs

The generated pulse results in hits outside of the digitization time window.

→ For the Rev F TDCs the fast clear will empty these out of time hits, while the Rev D TDCs will require additional time to clear these out of time hits.

To see this effect we compared the results for pulsing the inner four superlayers with the results of pulsing the entire chamber.

V64 of the DSP code has a narrower digitization window 306 ns compared with 500 ns. It also has an offset of 80 ns.

→ The fast clear clears out hits after the end of the digitization time window - but does not clear hits before the time window.

For V61 which starts at t=0 we see a , while for V64 we see the extra time needed to clear the prehits.

SL ON	Pulsing Period	~hits/chan 500 ns window	Readout Rate V61	V64
1-8	500ns	1	1530Hz	1529Hz
1-8	250ns	2	1035Hz	1056Hz
1-8	167ns	3	751Hz	766Hz
1-8	125ns	4	618Hz	629Hz
1-8	100ns	5	534Hz	527Hz
1-4	500ns	1	2473Hz	2630Hz
1-4	250ns	2	1828Hz	2092Hz
1-4	167ns	3	1388Hz	1575Hz
1-4	125ns	4	1232Hz	1318Hz
1-4	100ns	5	1210Hz	1167Hz
1-4	83ns	6		1062Hz
1-4	71ns	7	1205Hz	1043Hz
1-4	63ns	8		1019Hz
1-4	50ns	10	1173Hz	979Hz

v61 window is 0-500ns
v64 window is 80-386ns

The rates represent the absolute worst case...

Hits outside the digitization window and hits on all channels

Virtual VRB?

The TRACER data path is limited to about 12 MB/s

We can achieve over 60 MB/s transfer rates over GigE.

The VME readout rate will be the limiting factor

In the current system we use TRACER SPY mode and can achieve measured rates of 10 MB/s for event sizes of 8000 Bytes/Crate

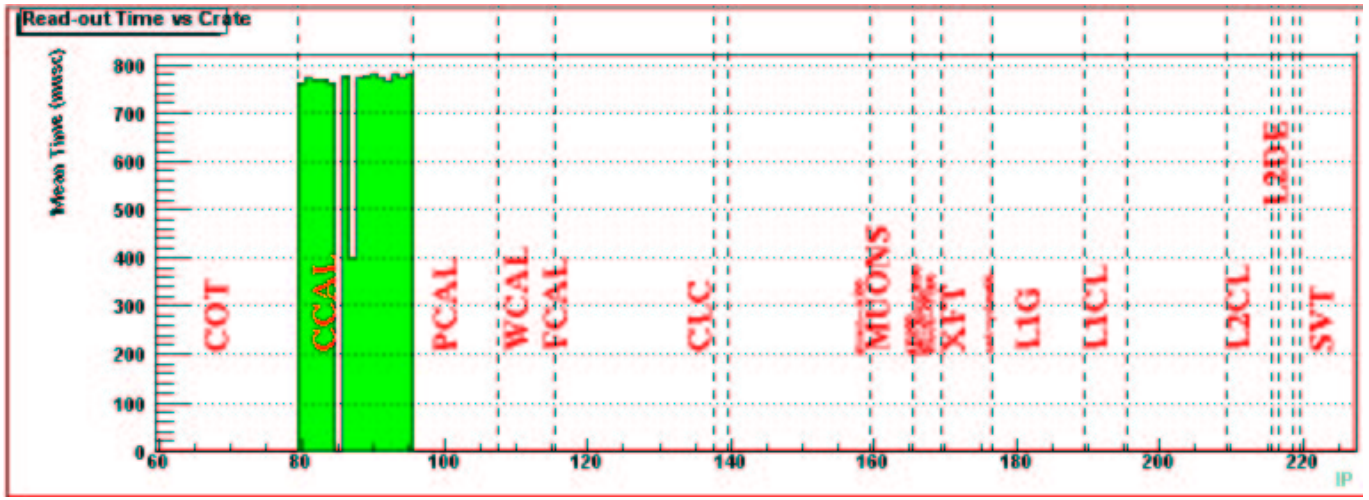
Using Chained Block Transfer we can achieve about 15 MB/s. If data is sent out over VME we would need additional overhead, reducing the effective throughput.

Assuming 3 hits/channel on every channel on every event, the required bandwidth is about 10MB/s with 10000 Bytes/Crate.

$\rightarrow$ We should be able to achieve this with the TRACER

MVME 5500 Evaluation

We would like to make use of the MVME 5500 in the COT crates and move the MVME2400 to the CCAL crates



We currently have three boards on hand for further development, will need an *additional 20 → $60000*.

We ran with the MVME5500 in a imu crate

→ Crate processor would freeze up about once per shift

→ Did not respond to a remote reset...

Conclusions

→ Looks like we will be able to achieve the Run II target rate of 1000 Hz with the existing TDCs and using the TRACER.

→ Need to consider the long term maintainability of the TDCs

→ We have taken a cosmic run with the new DSP format - this can be used to work on offline code changes.

→ Extrapolations from current conditions are tricky and depend on beam conditions and the trigger mix.

→ We now have available higher luminosity runs and can make more accurate extrapolations.